

## The microstructure and electrochemical performance of the Al-10Si-3.5Fe-xZn-yGa alloys for hot-dip galvanizing in low-chloride environments

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**Abstract** The microstructure and electrochemical performance of Al-10Si-3.5Fe-xZn-yGa alloys in low-chlorine environments were studied by SEM observation and electrochemical analysis. The microstructure of Al-10Si-3.5Fe-xZn-yGa alloys consisted of Si phase,  $\tau_6$ , and  $\alpha$ -Al matrix. The addition of Zn or Ga did not affect the morphology and phase of the microstructure. Pitting corrosion, galvanic corrosion of  $\alpha$ -Al matrix with Si phase and  $\tau_6$ , and anisotropic corrosion of  $\tau_6$  occur in the low-chloride environments for the alloys. The addition of Zn not only promoted the development of pitting pits on the  $\alpha$ -Al matrix but also reduced the electrode potential of the  $\alpha$ -Al matrix, increased the galvanic corrosion potential difference, and accelerated the corrosion rate of the  $\alpha$ -Al matrix. The addition of Ga could induce pitting corrosion on the surface of intact  $\tau_6$  and  $\alpha$ -Al matrix synchronously, reducing both electrode potential and accelerating the alloy's corrosion rate. The synergistic action of Zn and Ga could promote the alloy's sustained activation. Corroded  $\tau_6$  developed cracks and fragmentation, with the resulting cracks serving as pathways for the ingress and egress of  $\text{Cl}^-$  and other particles, leading to internal corrosion of the alloy. The stress generated during the fragmentation process of  $\tau_6$  promoted extensive delamination of the alloy surface, preventing corrosion products from covering the alloy's surface.

**Keywords:** Al-10Si-3.5Fe-xZn-yGa alloys; Microstructure; Electrochemical performance; Activation; Low-chlorine environments